

Genetics and Synthetic Biology: Superheroes

Objective: to teach middle school (and high school) aged students about genetics, synthetic biology, and genetic engineering through the frame of superheroes. This twist to such a broad and intricate field will hopefully introduce students to synthetic biology as well as excite a new generation of researchers.

Piloted: at the After-Dark Exploratorium Science Fiction event on August 7, 2014

Science background needed for this curriculum:

1. The scientific method.
2. Basic cell anatomy.
3. DNA and genes.

Background information for instructors:

1. Background Superhero Origin Stories found at:
[http://2014.igem.org/wiki/images/5/51/1.2014 UCSF UCB Background Superhero Origin Stories.pdf](http://2014.igem.org/wiki/images/5/51/1.2014_UCSF_UCB_Background_Superhero-Origin_Stories.pdf)
2. Science Fiction Superpowers found at:
[http://2014.igem.org/wiki/images/f/f4/2.2014 UCSF UCB Science Fiction Superpowers.pdf](http://2014.igem.org/wiki/images/f/f4/2.2014_UCSF_UCB_Science_Fiction_Superpowers.pdf)
3. FAQ to common questions students may ask AND disclaimers for this curriculum found at:
[http://2014.igem.org/wiki/images/d/d9/3.2014 UCSF UCB FAQ.pdf](http://2014.igem.org/wiki/images/d/d9/3.2014_UCSF_UCB_FAQ.pdf)

Materials for curriculum:

1. Gene cards found at
[http://2014.igem.org/wiki/images/e/e7/4.2014 UCSF UCB Gene cards.pdf](http://2014.igem.org/wiki/images/e/e7/4.2014_UCSF_UCB_Gene_cards.pdf)
2. Science and Superhero Slideshow found at
[http://2014.igem.org/File:5.2014 UCSF UCB Superhero and Science Slides \(animated\).ppt](http://2014.igem.org/File:5.2014_UCSF_UCB_Superhero_and_Science_Slides_(animated).ppt)
3. Handouts on Synthetic biology found at
[http://2014.igem.org/wiki/images/0/0d/6.2014 UCSF UCB iGEM Synthetic Biology paper.pdf](http://2014.igem.org/wiki/images/0/0d/6.2014_UCSF_UCB_iGEM_Synthetic_Biology_paper.pdf)
4. Handouts on Central Dogma (from the 2013 iGEM team) found at
http://2013.igem.org/wiki/images/d/d3/Central_Dogma.pdf
5. Handouts on Transformation (from the 2013 UCSF iGEM team) found at
<http://2013.igem.org/wiki/images/b/b9/MicroTransformation.pdf>
6. (Optionally) PDF of Superhero Slides
[http://2014.igem.org/wiki/images/8/86/9.2014 UCSF UCB Superhero Slides.pdf](http://2014.igem.org/wiki/images/8/86/9.2014_UCSF_UCB_Superhero_Slides.pdf)

Learning Goals and Objectives:

1. Students will learn be introduced to the developing field of synthetic biology. A condensed understanding of the underlying principles and technologies of synthetic biology will be presented in this lesson.
2. Students will be taken through the cloning process essential to synthetic biology and go in depth about the various steps in order to genetically engineer an organism.
3. Students will review concepts of DNA and genes and reinforce their understanding of genomics.

Activities:

1. Brainstorm and discuss (5 min)
2. Present slideshow and pass out handouts. (20-30 min)
3. Work in groups to plan a hypothetical experiment (20-30 min)

I. Brainstorm/Warm-Up (5 min)

Reflect on these questions:

1. If you could have any superpower, what would it be?
2. Does this superpower exist in nature?
3. If possible, how would you scientifically explain how this power works?

Spend a few minutes discussing as a class to discuss some plausibility behind powers.

II. Powerpoint Lecture and Handouts (20-30 min)

1. Pass out the three handouts provided in the curriculum packet:
 - a) Synthetic Biology
 - b) Central Dogma of Biology
 - c) Transformations
2. Teach using the slideshow as a teaching guide. Here are some key topics and questions raised in the slides and handouts:
 - a) What is synthetic biology?
 - b) What is the scientific method?
 - c) What is genetic engineering?
 - d) How does the cloning process work?
 - e) Why are we able to do synthetic biology? What principles and technologies make this possible?
 - f) What is transformation?
 - g) What are mutations?
 - h) How would you make a superhero?

III. Group project (20 -30 min)

In groups of 4-6 people, review the brainstorming exercise each member did and decide on the most plausible superpower in nature (or hand out superpowers chosen from the list given in the lesson packet). Using what you learned today, design an experiment to create an organism with this superpower. Draw up a flowchart (using the scientific method) to design such an experiment.

Afterwards, discuss what safety precautions you would make to ensure that you are following safe lab procedures and that the environment has no risk of harm from this project.

What applications could this project have for the public?

What ethical questions does this project face?